AIRPORT ILLUMINATION

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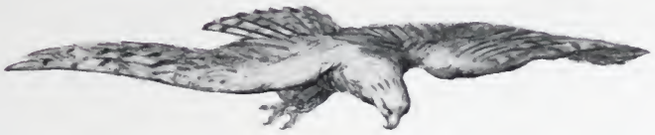
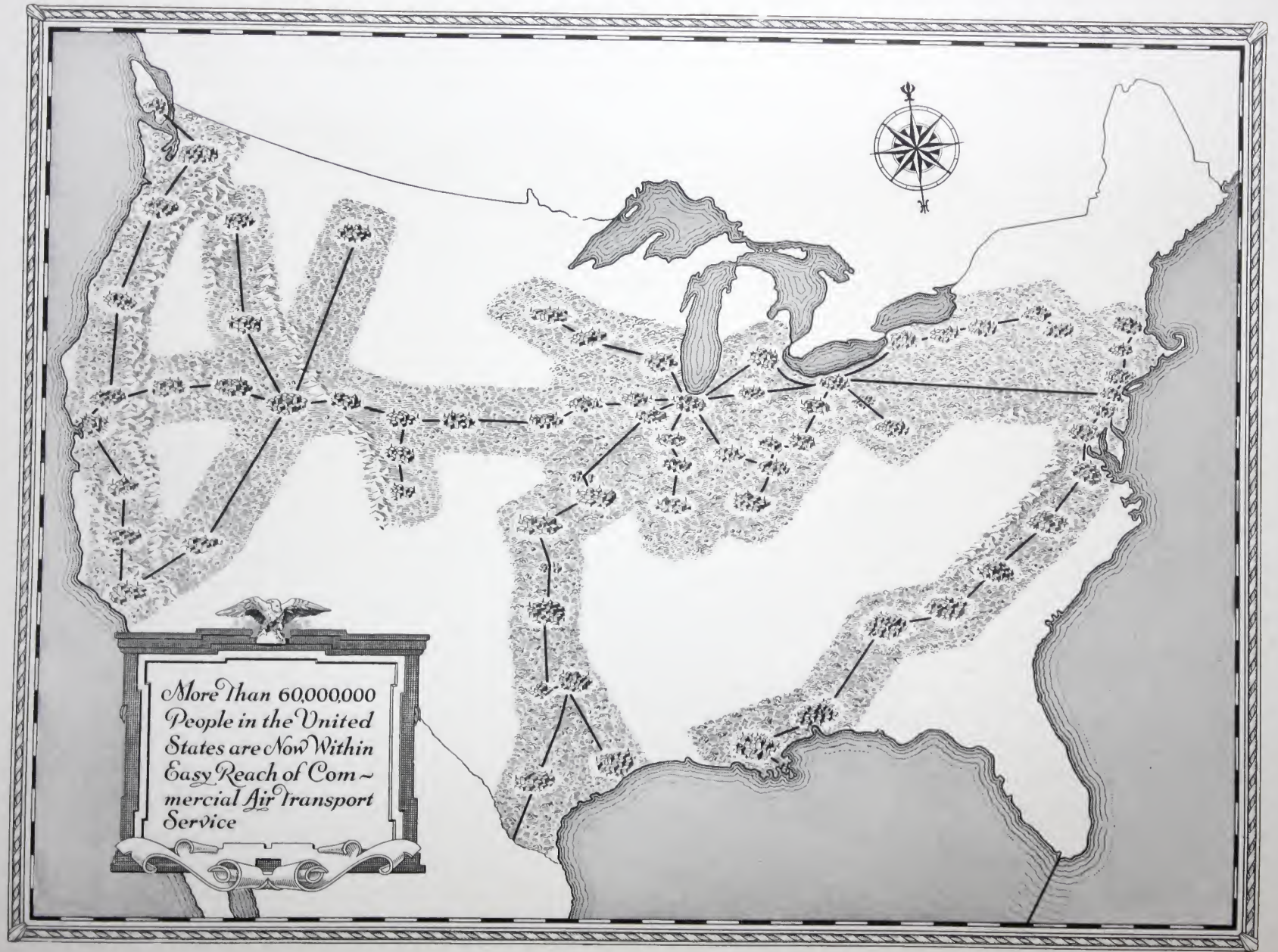


For I dipt into the future, far as human eye could see,
Saw the vision of the world, and all the wonders
that would be;
Saw the heavens fill with commerce, argosies of
magic sails,
Pilots of the purple twilight, dropping down with
costly bales.

TENNYSON (1842)

GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

GEA-982


More Than 60,000,000
People in the United
States are Now Within
Easy Reach of Com-
mercial Air Transport
Service

Airport Illumination

"The only factors that should be considered in planning the airport are those involving provisions for the best possible field and equipment to accommodate air traffic and the aircraft industry. The airport will automatically receive the highest possible Department of Commerce rating in such a case and will rank correspondingly with airports of neighboring cities."

WILLIAM P. MACCRACKEN, JR.,
Assistant Secretary of Commerce for Aeronautics.

(*Airports, April, 1928*)

IN 1927, fifteen air-transport lines were in regular operation. Their principal business was to carry United States mail under contract with the Post Office Department. Additional air mail routes are now being established, and within a short time a large majority of the urban population of the United States will be either directly on an air-mail line or within easy access of its facilities. The vast population now being served is graphically illustrated by the accompanying map. The great time-saving benefits of the air mail are already available to over 62,000,000 people in this country.

The Department of Commerce is actively interested in the development and expansion of existing airways. It has already installed electric beacons at ten-mile intervals on routes reaching from the Atlantic to the Pacific and from Canada to the Gulf of Mexico. On main routes, it has provided intermediate fields every thirty miles, where pilots may safely land in an emergency. Additional facilities are planned, such as weather information, and radio communication and beacon service. But neither this Department nor any other part of the National Government undertakes the establishment or maintenance of airports. That is left to the communities on the route, all of which are urged to provide airports—either from public or private funds.

To derive the utmost advantages from air service, airports must be made available for safe landings both day and night. Continuous operation is just as essential to air transportation as to all other public utilities. An airport without provision for night service is not rendering full value to either the community which supports it or the air transport companies. The General Electric Company therefore suggests that your airport provide twenty-four-hour service; that its landing facilities, hangar accommodations, and means for servicing planes be not only complete but usable at all times.

Nearly ten years ago, the General Electric Company, with a generation's experience in the solution of all types of lighting problems, engaged in the development of apparatus for airport and airway illumination. Progress has been rapid, and results now show that over seventy per cent of the lighting equipment employed on the airways and airports of this country is of General Electric manufacture.

On the following pages are described the applications and design of General Electric equipment.

24-in. Rotating Beacon

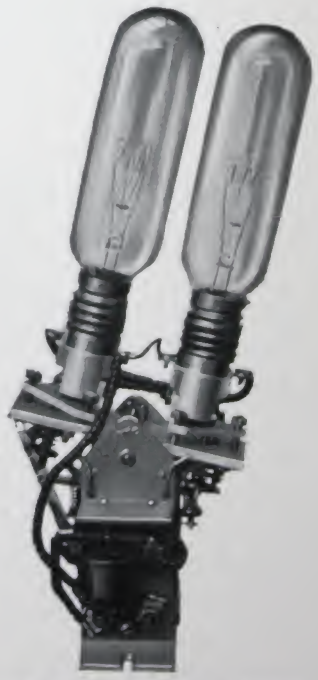
24-inch Rotating Beacon

The rotating beacon plays a very important part in the lighting scheme of the modern airport, for it is depended upon to guide the pilot to the field. It is obvious that a light source serving this purpose must be distinguishable from the many thousands of other light sources which the aviator sees from the air. This distinctive characteristic may be obtained by intensity, motion, or color, or combinations of these. Intensity and motion are most commonly employed at present, although a great deal of study is being given to the question of color. The G-E revolving beacon is identified by a beam of high candle power and a turning movement in the horizontal plane; the revolving feature serves to extend its effectiveness in every direction. Such a light source contrasts vividly with its surroundings and serves to locate the airport for a pilot anywhere within a radius of many miles.

This beacon has a 24-inch parabolic mirror in the focus of which is placed either a 1000-watt, 30-volt, T-20 or a 1000-watt, 110-120-volt, T-20 incandescent lamp. The former lamp delivers approximately 7,000,000 beam candle power with a 3-degree beam; the latter lamp delivers 2,300,000 beam candle power with a 5-degree beam. The filament of the 30-volt, 1000-watt lamp is more concentrated than the filament of the 1000-watt, 110-volt lamp and consequently produces a narrower beam and a higher beam candle power.

The rotating mechanism of the beacon is housed in the base. It consists of a G-E motor with worm and gear train arranged to turn the beacon at a speed of six revolutions per minute. This is the standard speed of rotation for beacons on airways and airports of the United States; however, beacons with other speeds such as nine, two, one, or one-half r.p.m. can be furnished upon order. All beacons are equipped with a friction clutch which permits an operator to stop its rotation without shutting off the driving motor. A set of slip rings and brushes on the rotatingshaft carries the electric current to the lamps. All moving parts are mounted on ball bearings.

The beacon should be placed on the top of a hangar or on a steel tower. This elevation should enable it to clear surrounding obstructions, and increase its range of visibility without causing any annoyance in the neighborhood. It is the practice to place the lower edge of the beam on the horizontal; that is, a 3-degree beam would be elevated 1½ degrees



Automatic Lamp Changer

Installation of Rotating Beacon on 50-foot Steel Tower

above the horizontal. The particular site for installing the beacon should be chosen only after a study of local conditions with respect to the topography of the field and vicinity, the likelihood of its being a hazard in landing and taking off, convenience in maintenance, etc. Where circumstances do not permit the regular presence of attendants at the field, a lamp changer is available which functions automatically to place a new lamp in focus in the event of failure of the lamp in operation. This device consists of series and shunt coils, the former, in normal operation, holding the latter on open circuit. When a lamp fails, the deënergized series coil permits current to flow in the shunt coil, the plunger of which trips a latch and permits the new lamp to swing into focus. Current does not flow in the shunt coil except during the changeover operation.

The beacon also contains the flashing mechanism for "on-course" lights, which synchronizes their flashes with the revolutions of the beacon. The "on-course" lights serve to keep a pilot on his course, and the flashes indicate the number of the beacon along the airway. "On-course" lights consist of floodlights with red lenses and 500-watt lamps. They have a beam spread of approximately 40 degrees. Two units are placed near the beacon and point in opposite directions along the airway. A pilot on the course will observe the distinctive flashes of these "on-course" lights, and failure to see them indicates to the pilot that he is off this course.

While "on-course" lights are not now required at airports, they are an essential part of the lighting equipment for airways. Therefore, provision for their operation is incorporated in the G-E rotating beacon.

Showing Boundary Light Installed with Pipe Support

Series Unit Disassembled

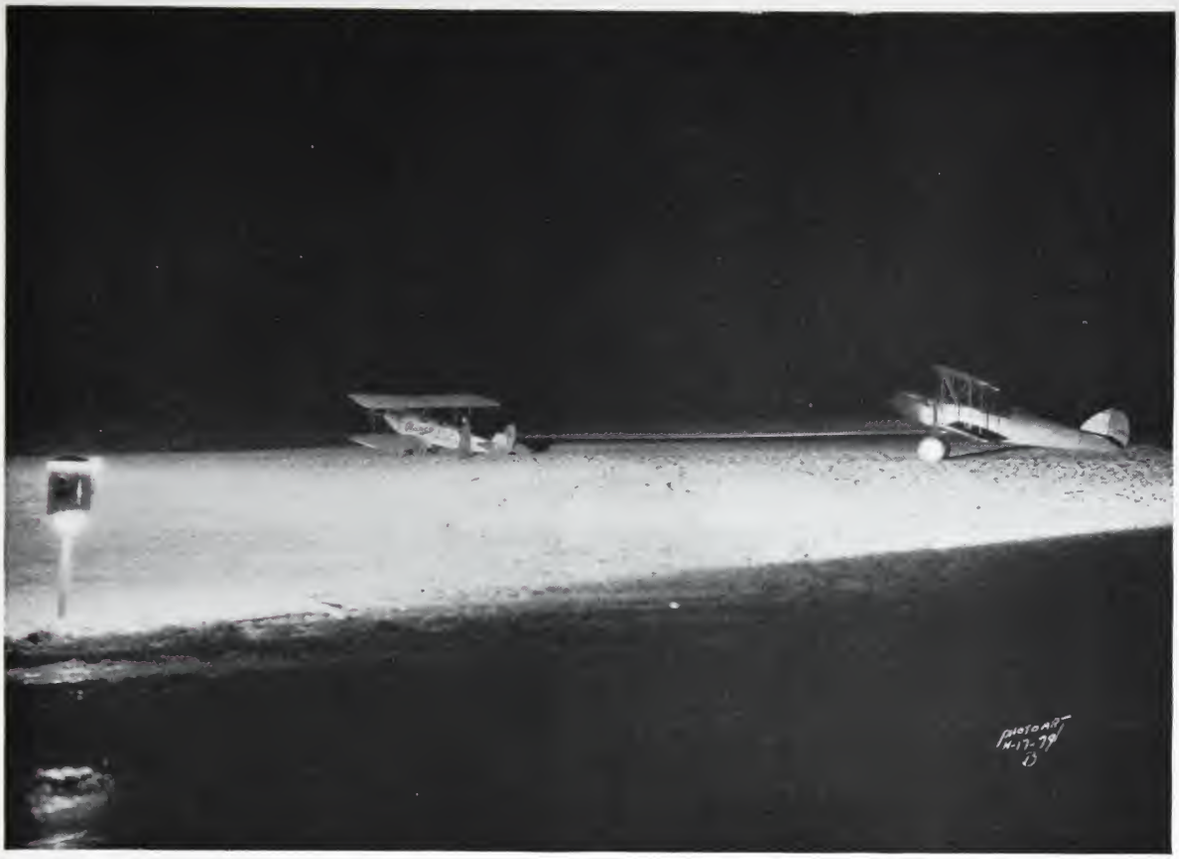
Multiple Unit

Boundary Lights

The recommended practice for installing boundary lights is to place them not more than 250 feet apart around the border of the field. Those indicating the best line of approach are equipped with green-glass globes, while those near obstructions are equipped with red-glass globes. Clear-glass globes are used to mark the field boundaries. This practice permits the use of one type of unit for marking approaches, obstructions, and boundaries.

These G-E units are designed for dependable service and have several important features of construction. Among them are the use of corrosion-resisting metals and provision for draining off condensate from the inside of the globe before it reaches the casing.

Local conditions will determine whether a series or multiple circuit should be employed. In either case, the boundary units are mounted about three feet above ground on rigid pipe supports.



This Illumination is Produced by One Unit

180-degree Floodlight

180-degree Floodlight

This 180-degree floodlight is used to illuminate landing fields of irregular shape by the distributed method. A number of these units are installed along the borders of the runways. Each is mounted about three feet above the ground on a two-inch pipe support. The distance between units should be about 250 feet. The circuit can be either series or multiple, and in either case the parkway cable is buried in the ground and does not require conduit piping.

The unit itself is of simple construction and consists essentially of a 180-degree Fresnel lens at the focal point of which is placed the 1000-watt incandescent lamp. A spherical mirror of silvered glass is fixed to the inside of the casing back of the lamp. This utilizes light that would otherwise be wasted. The focusing mechanism provides accurate adjustment of the light center and is operated by a knurled knob. The peep sights in the casing are also of assistance in properly locating the lamp filament with respect to the focal point of the lens. Lamp renewals are made after removing the cover of the unit.

Showing Illumination Obtained with Airport Twin Floodlight

Another Installation of the Airport Twin Floodlight. The Unit in This Photograph is Mounted within a Special Housing

Airport Twin Floodlight

The twin floodlight was developed by General Electric for the illumination of airports. It has a beam divergence of over 80 degrees in the horizontal plane and only six degrees in the vertical. This provides the necessary illumination and yet confines the beam to a low height which minimizes glare. This unit operates with two incandescent MAZDA lamps of either the 5- or 10-kw. size and is inherently suited for remote control.

The reflecting surfaces consist of two 24-inch parabolic glass mirrors, and the front of the housing is enclosed by convex glass lenses. Large hinged doors are provided on each side of the housing to give easy access to the lamps.

A control panel fitted with contactors and a time-delay relay is mounted in the rear of the mirrors and can be reached through a hinged door. This equipment is for the automatic connection of the lamps upon starting, first in series and then in multiple. Lamps of such large capacity are not suited for immediate connection to full-line voltage; therefore, this provision is made. Local control is accomplished by a small tumbler switch mounted on the casing. Remote control is obtained by means of a similar switch and a Novalux controller. The latter is connected in the primary of the transformer which supplies the floodlight. The transformer is located near the unit, but the controller and tumbler switch are at the control point, which is generally the airport office.

The proper location for installation of the airport twin unit is determined by the shape of the field and the direction of the prevailing wind. The installation of more than one unit is recommended because of varying wind directions. Planes must land into the wind and preferably in the same direction as the projected light. While it is possible to land facing directly into the light beam, it is not advisable.

Ceiling Light Installed on Hangar Roof

Ceiling Light

The ceiling light is used to determine the approximate height of fog or clouds above the ground, so that this information can be transmitted along the airway to approaching pilots. The method generally employed is to project a narrow beam of high intensity upward at an angle of 45 degrees. The height of the ceiling is then determined by pacing the distance from a point near the projector to a point directly under the beam reflection on the clouds. This method is based on the simple geometric relation between the sides of a right isosceles triangle.

Wind Cone and Lighting Units

The unit consists essentially of an incandescent searchlight properly mounted for this application. It is constructed of non-ferrous metals and is provided with a silvered, parabolic reflector and a focusing mechanism. Concentric metal bands within the lens cut off stray light and help to produce a well-defined beam. A 500-watt lamp is recommended.

Wind-cone Lights

An approved and practical method for illuminating the wind cone is to arrange four reflectors, each one equipped with a 100-watt lamp, as shown in the accompanying illustration. An obstruction light with a red-glass globe should surmount the pipe support.

Transformer and Control

Current for the boundary-light series circuit is supplied by a constant-current transformer, usually of the automatic pole type, although a non-automatic, station-type transformer can be used. The pole-type transformer is illustrated, and the accompanying table shows the capacities of the various sizes of these transformers in terms of 60-candle-power lamps, the size of lamp generally used in boundary-light units.

Control of the boundary-light circuit can be accomplished by installing a Novalux controller. The operating coil of this controller is wired to a snap or tumbler switch, which can be located in the operator's office. This coil is energized from a 110-volt circuit, either alternating or direct current. It is a much safer arrangement than the use of a manual switch on the primary of the transformer, as only the low-voltage wires are brought into the building. Lightning arresters and primary cutouts must be provided for each transformer.

Novalux Controller

Pole-type Constant-current Transformer

Kw. Rating	Number of 60-c.p. Lamps	WEIGHT IN LB.		
		Net Less Oil	Ship. Less Oil	Oil
1	21	200	260	119
2	43	215	275	119
3	65	285	360	231
5	109	330	410	231
7½	163	405	490	280

Wire, Cable, and Conduit

The cable recommended for series boundary-light circuits is a single, solid No. 8 A. W. G. conductor, and is of the parkway type, being rubber-insulated, covered by a lead sheath, and protected by steel armor. This cable should be buried in the ground about 12 inches deep and brought up at each boundary light through the pipe support. For circuits up to and including forty-three 60-c.p. lamps, the standard 600-volt thickness of insulation is sufficient; while for more than forty-three lamps, the 2500-volt cable is recommended.

General Electric also manufactures BX and BXL cable, all types of flexible cords, and Greenfield rigid conduit. G-E distributors are prepared to furnish complete wiring supplies.

Parkway Single Conductor

"BX" Cable, Twin Conductor

Greenfield Rigid Conduit

The 15-battery Tungar

Tungar Battery Chargers

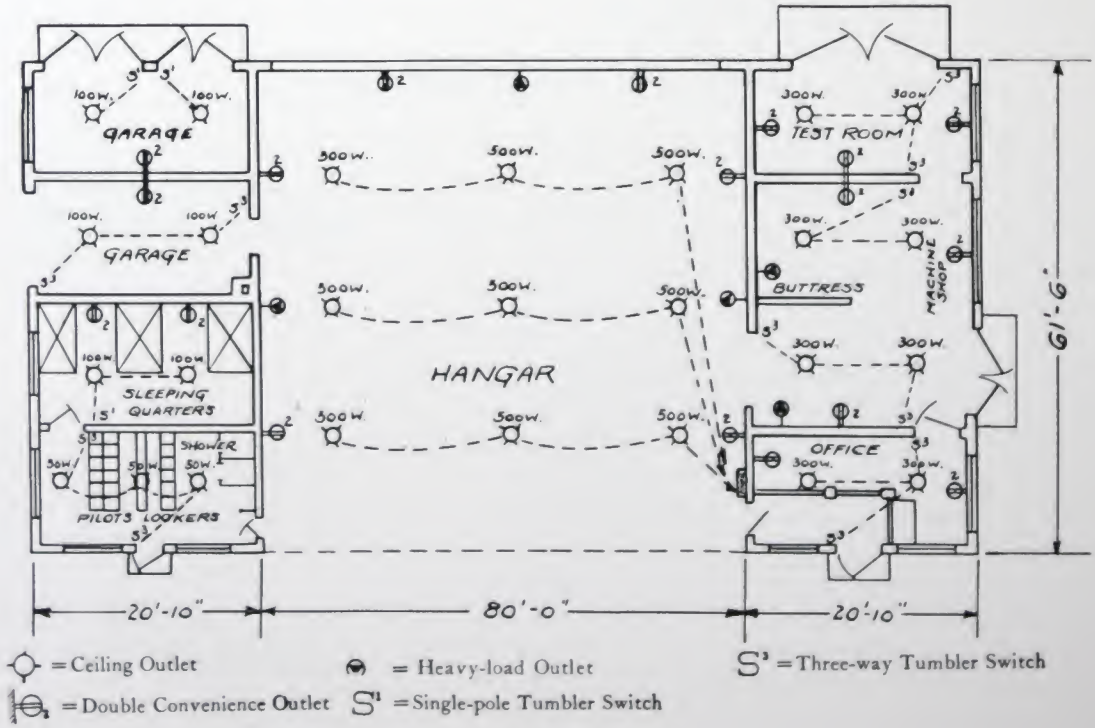
The 15-battery Tungar is recommended for charging storage batteries at airports. It will charge 6- and 12-volt batteries simultaneously and has the same reliable characteristics that have made Tungar chargers famous in the radio field. The 15-battery unit will charge from one to fifteen 3-cell batteries at a rate of six amperes; however, Tungars of all ratings are available. They are an essential part of service equipment and meet every requirement of operation and maintenance.

Wiring Devices

The wiring of airport buildings for interior and exterior illumination and for machine-shop accessories such as portable drills, cranes, and lathes is of major importance. Care should be taken to provide a sufficient number of outlets and to insure maximum protection against fire. Overheated wires, excessive arcing, and short circuits are avoided by the proper selection of wiring devices and good installation methods.

The wiring devices manufactured by this Company include all types of lamp holders, fixture receptacles, switches, fuses, fuse blocks, etc.

A plan view of a typical hangar showing an approved and practical wiring installation is illustrated below. Note the location of lighting outlets to obtain the most efficient illumination. Note also the number and location of convenience outlets—a feature which is most desirable in any wiring installation.



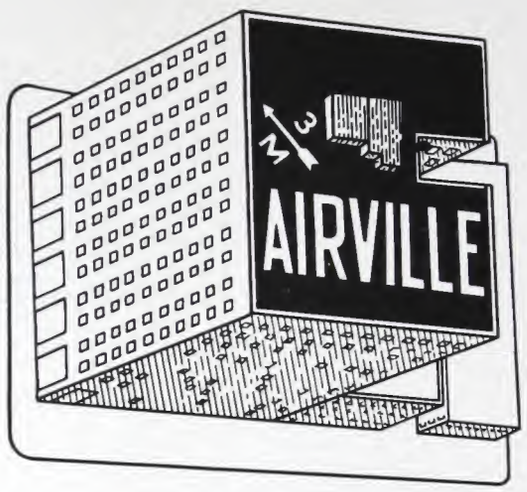
Air Marking Signs

The roofs of factories, storehouses, or other large buildings in the city or town nearest the airport should be marked as illustrated in the accompanying drawing. In addition to the name of the city or town, the sign also indicates the direction and distance to the airport. This is of considerable assistance to any pilot flying over the city, because it enables him to locate the airport without a prolonged search.

The importance of air marking signs will increase with the advance of air transportation. They serve the same purpose as road markers on the highway and have even greater significance with respect to safety.

An economical and effective air marking method is to paint the sign in chrome yellow on the roof surface, the letters being at least twelve feet high. Floodlights can be used for illumination after dark, provided the intensity of light on the letters is from ten to fifteen foot-candles. This intensity is essential for good visibility.

It is quite apparent that a thin layer of dust or snow will be sufficient to obliterate this type of air marking sign, however, it serves as a basis upon which to plan future endeavors.



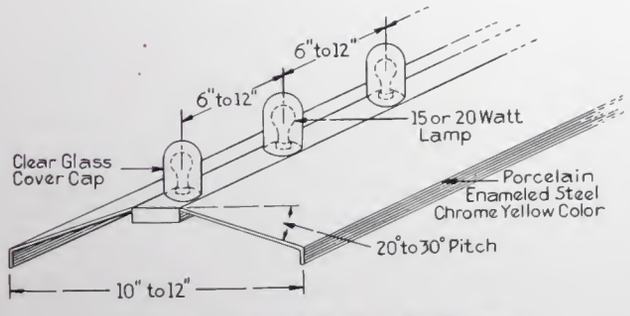
An Air Marking Sign

An exposed-lamp sign is probably the best type with respect to legibility after dark, permanence, and economy of operation. It can be made up of letters about six feet high with a stroke of ten or more inches. A suggested cross section of the letters is shown below. This method of construction avoids, to a great extent, obliteration by dust or snow. The lamps should be fifteen or twenty-five watts, spaced on centers of from six to twelve inches. Provision should be made to use fifty-watt lamps in case it is desired to use colored light.

Letters made up of chrome-yellow porcelain-enameled steel give excellent daylight visibility and contrast with almost any roof surface.

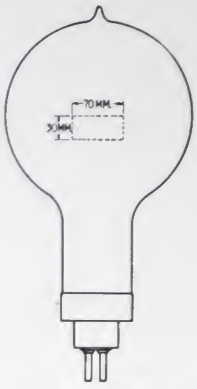
The framework for supporting a sign of this type is not of necessity as strong as that required by a similar sign mounted vertically. The lowest surface of the sign should be high enough above the roof surface to meet the requirements of local ordinances. This height is usually about five or six feet and is enough to avoid drifting snow. A sign of this character is legible from an altitude of 3000 feet.

Sign manufacturers can furnish suitable air marking, electric signs.

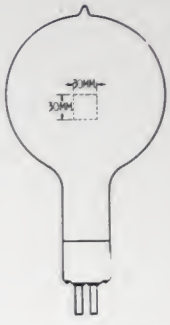


Suggested Cross Section for Letters

Mazda Lamps



Airport Twin



Airport Twin

180-degree

FIELD FLOODLIGHTS

10 kw., 115 volts, G-80 bulb, C-13 filament, 1851 base
Over-all length 20 in.
Light-center length 12 in.
Rated average life 100 hr.

5 kw., 115 volts, G-64 bulb, C-13 filament, 1848 base
Over-all length 15½ in.
Light-center length 9 in.
Rated average life 100 hr.

1000-watt projection 115 volts, T-20 bulb, C-13A filament, mogul screw base
Over-all length $9\frac{1}{16}$ in.
Light-center length $4\frac{3}{4}$ in.
Rated average life 50 hr.

24-in Beacon

24-in Beacon

On-course

AIRPORT AND AIRWAY BEACONS

1000-watt, 110, 115, 120 volts, T-20 bulb, C-13A filament, mogul screw base
Over-all length $9\frac{1}{16}$ in.
Light-center length $4\frac{3}{4}$ in.
Rated average life 500 hr.

1000 watt, 30 volts, T-20 bulb, C-13 filament, mogul screw base
Over-all length $9\frac{1}{16}$ in.
Light-center length $4\frac{3}{4}$ in.
Rated average life 500 hr.

500-watt floodlight lamp, 110, 115, 120 volts, G-40 bulb, mogul screw base
Over-all length $7\frac{1}{16}$ in.
Light-center length 4¼ in.
Rated average life 800 hr.

Ceiling Light

Airports

Intermediate Fields

BOUNDARY LIGHTS

500-watt projection lamp, 110, 115, 120 volts, T-20 bulb, C-13 filament, medium screw base
Over-all length 5½ in.
Light-center length 3 in.
Rated average life 50 hr.

600 lumens, 6.6 amperes, 60 c.p., C-8 filament, mogul screw base, series lamp, S-24½ clear bulb
Over-all length $7\frac{1}{8}$ in.
Light-center length $5\frac{3}{4}$ in.
Rated average life 1350 hr.

15 watt A-17, 25 watt A-19, or 40 watt A-21, 115 volt general service, inside frosted lamps, medium screw base
Over-all lengths $3\frac{15}{16}$ 2nd $4\frac{7}{16}$ in. respectively
Rated average life 1000 hr.

Mazda Lamps

Airport (Series)

1000 lumens, 6.6 amperes, C-8 filament, S--24½ clear bulb, mogul screw base, series lamp.
Over-all length 7⅛ in.
Light-center length 5⅜ in.
Rated average life 1350 hr.

Airport (Multiple)

100 watt, 115 volts A-23 medium screw base, inside frosted lamp
Rated average life 1000 hr.

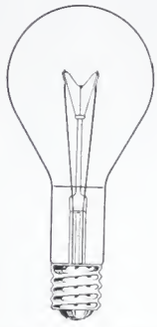
Intermediate Fields

50 watt, 115 volts, A-21, or 60 watt 115 volts, A-21 inside frosted lamp medium screw base.
Rated average life 1000 hr.

OBSTRUCTION AND MARKER LIGHTS

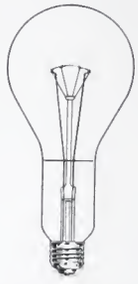
Wind Cone

100 watt, 115 volts, A-23 inside frosted lamps medium screw base
Rated average life 1000 hr.



Hangar (Exterior)

300 watt, 115 volts, PS-35 clear bulb lamp, mogul screw base
Light-center length 7 in.
Rated average life 1000 hr.
200 watt, 115 volts, PS-30 clear bulb lamp, medium screw base
Light-center length 6 in.
Rated average life 1000 hr.



Hangar (Interior)

300 watt and 200 watt lamps as for hangar exterior service
Rated average life 1000 hr.

General

100 watt, 115 volts, A-23
60 watt, 115 volts, A-21
50 watt, 115 volts, A-21
40 watt, 115 volts, A-21
25 watt, 115 volts, A-19
(All the above lamps inside frosted)
Rated average life 1000 hr.

Wing Tip

12 volts, 35 amp., G-25 bulb, inverted C-2 filament, mogul screw base
Over-all length 5¼ in.
Light-center length 3 in.
Burned horizontally or base down
Rated average life 50 hr.

Navigation

Mazda No. 1142, 12-16 volts 21 c.p.
S-11 bulb, D-c. base
Over-all length 2⅜ in.
Light-center length 1¼ in.
Burned in any position
Rated average life 300 hr.

Instrument

Mazda No. 68, 12-16 volts 21 c.p. S-11 bulb, D-c. base
Over-all length $1\frac{7}{16}$ in.
Burned in any position
Rated average life 200 hr.

It is important to operate Mazda lamps at the particular voltage for which they are designed. Operation at an overvoltage of only 1 per cent will reduce the life about 13 per cent. Undervoltage burning materially lowers the total lumen output of the lamps and increases the cost of light.

GENERAL ELECTRIC COMPANY

GENERAL OFFICE SCHENECTADY, N. Y.

Sales Offices—Address nearest Office

Akron, Ohio	159 South Main Street
Amarillo, Tex	802 South Grant Street
Atlanta, Ga	187 Spring Street, Northwest
Baltimore, Md	39 West Lexington Street
Binghamton, N. Y	19 Chenango Street
Birmingham, Ala	602 North Eighteenth Street
Bluefield, W. Va	307 Federal Street
Boston, Mass	84 State Street
Buffalo, N. Y	39 East Genesee Street
Butte, Mont	20 West Granite Street
Canton, Ohio	700 Tuscarawas Street, West
Charleston, W. Va	201 Capitol Street
Charlotte, N. C	200 South Tryon Street
Chattanooga, Tenn	536 Market Street
Chicago, Ill	230 South Clark Street
Cincinnati, Ohio	215 West Third Street
Cleveland, Ohio	925 Euclid Avenue
Columbus, Ohio	17 South High Street
Dallas, Tex	1801 North Lamar Street
Davenport, Iowa	111 East Third Street
Dayton, Ohio	25 North Main Street
Denver, Colo	650 Seventeenth Street
Des Moines, Iowa	418 West Sixth Avenue
Detroit, Mich	700 Antoinette Street
Duluth, Minn	14 West Superior Street
El Paso, Tex	109 North Oregon Street
Erie, Pa	10 East Twelfth Street
Fort Wayne, Ind	1635 Broadway
Grand Rapids, Mich	201 Monroe Avenue
Hartford, Conn	18 Asylum Street
Houston, Tex	1016 Walker Avenue
Indianapolis, Ind	106 North Illinois Street
Jackson, Mich	212 Michigan Avenue, West
Jacksonville, Fla	11 East Forsyth Street
Kansas City, Mo	1004 Baltimore Avenue
Knoxville, Tenn	602 South Gay Street
Little Rock, Ark	223 West Second Street
Los Angeles, Calif	5201 Santa Fe Avenue
Louisville, Ky	455 South Fourth Street
Memphis, Tenn	130 Madison Avenue
Miami, Fla	25 Southeast Second Avenue
Milwaukee, Wis	425 East Water Street
Minneapolis, Minn	107 South Fifth Street
Nashville, Tenn	234 Third Avenue, North
Newark, N. J	20 Washington Place
New Haven, Conn	129 Church Street
New Orleans, La	837 Gravier Street
New York, N. Y	120 Broadway
Niagara Falls, N. Y	201 Falls Street
Oklahoma City, Okla	15 North Robinson Street
Omaha, Nebr	409 South Seventeenth Street
Philadelphia, Pa	1321 Walnut Street
Phoenix, Ariz	11 West Jefferson Street
Pittsburgh, Pa	535 Smithfield Street
Portland, Oreg	329 Alder Street
Providence, R. I	76 Westminster Street
Richmond, Va	700 East Franklin Street
Roanoke, Va	202 South Jefferson Street
Rochester, N. Y	89 East Avenue
St. Louis, Mo	112 North Fourth Street
Salt Lake City, Utah	200 South Main Street
San Antonio, Tex	601 Navarro Street
San Francisco, Calif	235 Montgomery Street
Schenectady, N. Y	1 River Road
Seattle, Wash	811 First Avenue
Spokane, Wash	421 Riverside Avenue
Springfield, Mass	1387 Main Street
Syracuse, N. Y	113 South Salina Street
Tacoma, Wash	950 Pacific Avenue
Tampa, Fla	112 Cass Street
Terre Haute, Ind	701 Wabash Avenue
Toledo, Ohio	520 Madison Avenue
Tulsa, Okla	409 South Boston Street
Utica, N. Y	258 Genesee Street
Washington, D. C	1405 G Street, Northwest
Waterbury, Conn	195 Grand Street
Worcester, Mass	340 Main Street
Youngstown, Ohio	16 Central Square

Canada: Canadian General Electric Company, Ltd., Toronto

Hawaii: W. A. Ramsay, Ltd., Honolulu

Motor Dealers and Lamp Agencies in all large cities and towns

SERVICE SHOPS

Atlanta, Ga	496 Glenn Street, Southwest
Buffalo, N. Y	318 Urban Street
Chicago, Ill	509 East Illinois Street
Cincinnati, Ohio	215 West Third Street
Cleveland, Ohio	1133 East 152nd Street
Dallas, Tex	1801 North Lamar Street
Detroit, Mich	700 Antoinette Street
Kansas City, Mo	819 East Nineteenth Street
Los Angeles, Calif	5203 Santa Fe Avenue
Minneapolis, Minn	410 Third Avenue, North
New York, N. Y	627 Greenwich Street
Philadelphia, Pa	1223 Washington Avenue
St. Louis, Mo	1009 Spruce Street
Salt Lake City, Utah	360 West Second South Street
Seattle, Wash	1508 Fourth Avenue, South

Special service divisions are also maintained at the following works of the Company: Erie, Pa.; Ft. Wayne, Ind.; Oakland, Calif.; Pittsfield, Mass.; Schenectady, N. Y.; and West Lynn, Mass.—River Works and West Lynn Works

BROADCASTING STATIONS

WGY, Schenectady, N. Y. KOA, Denver, Colo. KGO, Oakland, Calif.

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July, 1928 14M